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John H. Thompson,
Associate Director for Decennial Census
Bureau of the Census
Suitland Federal Center
Suitland and Silver Hill Roads, Bldg. 2, Room 3586
Suitland, MD 20233

Re: Commentary in response to proposed rule (**Federal Register**, Vol. 65, No. 119, pp. 38370–38371, June 20, 2000)

Dear Mr. Thompson:

Enclosed you will find commentary that I wish to submit regarding the proposed rule of the Department of Commerce referenced above. A copy of this letter and my commentary are being sent under separate cover to the office of the Honorable Dan Miller, Chairman of the House Subcommittee on the Census.

Sincerely,

Robert A. Koyak
Assistant Professor

encl: commentary
cc: Rep. Dan Miller

Comments regarding a proposed rule of the Department of Commerce, Bureau of the Census, "Report of Tabulations of Population to States and Localities Pursuant to 13 U.S.C. 141(c) and Availability of Other Population Information," **Federal Register**, Vol. 65, No. 119, pp. 38370–38371, June 20, 2000.

Robert A. Koyak, Ph.D.

On June 20, 2000 the **Federal Register** published a proposed rule to delegate from the Secretary of Commerce to the Director of the Census the decision to statistically adjust, or not to adjust, the 2000 census tabulations that the Census Bureau will report to the States[1]. The proposed rule was followed in the **Federal Register** by a notice from the Census Bureau that presented arguments in support of the proposed rule[2]. The Census Bureau reported its preliminary determination that it is feasible to produce a statistically adjusted census within the time frame mandated by law, and that it would be more accurate than an unadjusted census. Statistical adjustment is based on a coverage measurement survey, known as the Accuracy and Coverage Evaluation (A.C.E.), encompassing a random sample of approximately 314,000 housing units. In reaching its final determination the Census Bureau stated that it would bring "its technical judgment to bear in assessing the available data to verify that its expectations have been met."

I wish to take the opportunity to raise several points in response to the arguments set forth by the Census Bureau in its preliminary determination. The views that I express are my own, and do not reflect the official policy of the Naval Postgraduate School or the U.S. Department of Defense.

1. Presumption and the burden of proof.

The question of whether or not the U.S. decennial census should be adjusted with a coverage measurement survey has been debated in earnest among statisticians, demographers, and policymakers beginning with the 1980 census. In 1990 this issue was deliberated in considerable detail, particularly in response to litigation that sought to force an adjustment with data from the Post Enumeration Survey (PES)[3]. The Department of Commerce issued guidelines that required a burden of proof to be met in

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[1] Census Bureau, "Report of Tabulations of Population to States and Localities Pursuant to 13 U.S.C. 141(c) and Availability of Other Population Information," *Federal Register*, Vol. 65, No. 119, June 20, 2000, pp. 38370–38371.

[2] Census Bureau, "Accuracy and Coverage Evaluation; Statement on the Feasibility of Using Statistical Methods To Improve the Accuracy of Census 2000," *Federal Register*, Vol 65, No. 119, June 20, 2000, pp. 38374–38393.

[3] The PES was the analog of the A.C.E. in the 1990 Census, based on a sample of about 165,000 housing units.

order for a statistical adjustment to be used with the 1990 census[4]. The Commerce Secretary determined the following year that this burden of proof was not met, and the 1990 census was not adjusted. The courts subsequently upheld the Commerce Secretary's decision.

The burden of proof is substantial in the context of census adjustment. Measuring the accuracy of either an adjusted or unadjusted census at the national level is a nontrivial problem, and it becomes increasingly difficult at the state and sub-state levels. The Census Bureau has adopted the position that adjustment of the 2000 census should not have to meet a burden of proof by demonstrating greater accuracy over an unadjusted census. Instead, the Census Bureau believes that the burden should be the other way around:

> ... the Census Bureau's comprehensive ongoing analyses and experience with conducting coverage measurement surveys have led it to expect that the A.C.E. will improve overall numeric accuracy and that it will reduce the differential undercount. Therefore, statistical correction is appropriate absent strong evidence that it will degrade the overall quality of the final census data.[5]

The shift of presumption towards adjustment has been made despite the fact that an adjusted census has never been produced in the United States, nor has evidence been presented that an adjusted census is more accurate across the spectrum of geographic areas that are important to census stakeholders.

The new calculus raises a few basic questions. If the Census Bureau's comprehensive analyses and experience have led it to favor statistical adjustment, then why is there a need to relieve it of the burden of proof? And, if adjustment cannot meet the burden of proof, then how has it come to pass that the Census Bureau's comprehensive analyses and experience have led it to favor adjustment? What, essentially, is the difference between the Census Bureau's new calculus and its stating that "census adjustment works because we say it does?"

The Census Bureau defends its position by pointing to other census innovations that were not "burden of proof" tested before they were adopted. But these analogies have a central flaw. Statistical adjustment of the census is conducted "on top" of the uncorrected census. It is what statisticians call a calibration procedure. It is true, although not always appreciated, that all of the problems attributed to the unadjusted census are present, initially, in the adjusted census as well. If it is effective, statistical adjustment calibrates the census by reducing errors in the census, just as the calibration of a spectrometer corrects systematic bias exhibited by the machine.

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[4] Specifically, that the unadjusted census counts would be "considered the most accurate count of the population of the United States, at the national, state, and local level, unless an adjusted count is shown to be more accurate."

[5] Census Bureau, *Federal Register*, Vol. 65, No. 119, p. 38387.

Would a scientist consider it reasonable to accept what is claimed to be a calibration procedure without assurance of efficacy? If this standard seems too stringent, perhaps it is useful to ask if one would want to travel on an airline where the only assurance of good maintenance is that the mechanics "did something" that is assumed to be effective unless it is proved otherwise. I believe it is safe to assume that most airline passengers expect the airline to meet the burden of proof, just as the operator of a spectrometer demands assurance, expressed in warranty, that the manufacturer's calibration procedures do what they are supposed to do. Why should census stakeholders have to settle for a lesser standard?

2. Statistical adjustment: 2000 versus 1990

The Census Bureau represents the A.C.E. as a "monotonic" improvement over the 1990 PES, which further justifies its presumption in favor of adjustment. There undoubtedly are improvements. Over the last ten years information technology has evolved rapidly, much to the potential benefit of the A.C.E. The Census Bureau has devoted considerable effort to software quality assurance. And, the A.C.E. sample is larger than that of the PES[6].

There are also new components of the A.C.E. that are not obvious improvements over the PES. The treatment of those who moved between Census Day[7] and A.C.E sampling is illustrative. It is a tricky problem, due to the time lapse of several months between the census and the start of the A.C.E. sampling in 11,800 randomly selected blocks. Due to the mobility of the U.S. population, it is also a problem that, if not effectively addressed, could jeopardize the statistical validity of adjustment. According to the Census Bureau, about 16% of the U.S. population moved between March 1996 and March 1997, which if pro-rated amounts to 1.3% per month. Turnover rates are even greater for key segments of the population that are regarded as prone to undercounting. About 33% of renters moved during the same period (2.8% per month), as did 32% of people in the 20–29 age category (2.7% per month)[8]. Projected to the census time frame, it is clear that the turnover percentages are larger in magnitude than the undercount that the A.C.E. aims to correct.

In 1990 the PES handled movers with what is known as Procedure B. Procedure B used all PES-sampled persons as the base population for matching to the census. Those that resided at the same address during both the census and PES, and those that moved in after the census (in-movers), were counted. Those that moved from a PES-sampled block after April 1, 1990 (out-movers) were not counted. In contrast, the A.C.E. uses what is known as Procedure C, which excludes in-movers but attempts to include

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[6] However, the marginal benefit of increasing the sample size by a factor of two is not as great as it would appear. There are 448 post-strata to be used with the A.C.E., compared to 357 post-strata that were used with the PES, an increase of about 25%. Moreover, an increased sample size does not reduce nonsampling error (bias), which in census adjustment may be more substantial than sampling error.

[7] April 1, 2000.

[8] Census Bureau press release, July 23, 1998.

out-movers. Of course, out-movers cannot be counted directly. Information about out-movers is obtained from indirect sources, such as family members and neighbors.

It is difficult to conceive of Procedure C as a net improvement over Procedure B in the absence of evidence to that effect. Use of proxy information in lieu of direct counting stands to degrade the quality of data. By itself alone, the treatment of movers gives sufficient reason to require that the A.C.E. establish its efficacy without resting on presumption. And, the treatment of movers is not the only aspect of the A.C.E. that is different from the PES in ways that could negatively impact quality[9].

3. Accuracy claims: the CAPE report

The accuracy of a statistically adjusted census relative to an unadjusted census has been extensively debated, and it continues to be debated. This is not the place to revisit these arguments, nor is it necessary to do so. The Census Bureau offers no new evidence that statistical adjustment would improve the 2000 census. Instead, by re-evaluating past arguments it reaches remarkable, new conclusions.

For nearly eight years the CAPE report[10] has been read and re-read by those who follow the census adjustment debate. Those who read the Report will find it to be cautiously written, and often ambivalent about the benefits of adjusting the postcensal estimates based on the 1990 PES. While a majority of the Committee believed that adjustment improved the accuracy of state population totals[11], opinion was mixed for smaller areas:

> For smaller areas (generally, areas of less than 100,000 population), some of the Committee judged that the use of an unadjusted base for the estimates was better than the use of an adjusted base. Other Committee members concluded there was no way to determine whether an adjusted or unadjusted base was more accurate.[12]

It is telling that there is no record in the CAPE report of a Committee member who believed that an adjusted base was more accurate for areas of less than 100,000 population. The Committee was concerned about bias in the adjustment procedure, particularly correlation bias, for which Census Bureau models occasionally produced negative population counts. The Committee concluded that the effect of bias, which it estimated at between 22% and 45% of the estimated undercount depending on what was assumed about correlation bias, could not be removed safely from subnational adjusted census counts.

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[9] For a detailed discussion see P.B. Stark, "The 1990 and 2000 Census Adjustment Plans," Technical Report 550 (revised), Department of Statistics, University of California, Berkeley, May 2000.

[10] "Report of the Committee on Adjustment of Postcensal Estimates," (CAPE report), Bureau of the Census, August 1992.

[11] An adjustment of the 2000 census would apply to sub-state geographic areas only.

[12] CAPE report, p. 1.

In the new calculus, however, ambivalence and uncertainty are grist for the mill of adjustment. The Census Bureau wrote:

> The CAPE report, however, left the erroneous impression that the unadjusted census was more accurate at small geographic areas, generally areas with a population of fewer than 100,000.[13]

That makes it a tie, and by virtue of presumption ties are resolved in favor of adjustment. The Census Bureau mentioned evaluations that it subsequently conducted which it claims reinforced the tie, but in retrospect they were unnecessary. With presumption now in favor of adjustment, any kind of a tie is sufficient.

4. Accuracy claims: the tract level.

The Census Bureau claims that statistical adjustment can improve census accuracy down to the tract level in a numerical sense. This is distinguished from accuracy in a distributive sense. A census tract is an area that contains about 5,000 people on average. Tract-level accuracy is a strong claim, given the existence of bias in adjustment that the Census Bureau has acknowledged, and the lack of knowledge of how this bias is distributed across small areas. To support this claim, the Census Bureau cited the Census Bureau's Report to Congress, as revised in August 1997[14].

There are two problems with this claim. The first is that the census plan in August 1997 was substantially different from what was actually used in 2000. Under the August 1997 plan the coverage measurement survey was called the Integrated Coverage Measurement (ICM), which comprised a random sample of 750,000 households, more than twice as many as in the A.C.E. It also called for sampling-based non-response follow-up in the base census. In January 1999 the U.S. Supreme Court effectively invalidated this census plan, which was later revised into its present form.

The second problem is that the claim is untenable even for the census plan that was evaluated. The accuracy claim was based on simulations that the Census Bureau conducted at the request of the General Accounting Office[15]. Both the Report to Congress and the GAO Report explained that the simulations accounted for "... only those types of error that could be measured;"[16] in other words, ignoring bias[17]. Bias is

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[13] Census Bureau, *Federal Register*, Vol. 65, No. 119, p. 38389.
[14] U.S. Department of Commerce, Bureau of the Census. "Report to Congress—The Plan for Census 2000," revised and reissued August 1997, p. 44.
[15] U.S. General Accounting Office, "2000 Census: Progress Made on Design, but Risks Remain," GAO/GGD-97-142, July 1997.
[16] Report to Congress, p. 44.
[17] Report to Congress, p. 44, and GAO, p. 71. From GAO: "[the simulations do] not include possible errors from other sources, such as any bias in the statistical models used to produce the tract-level estimates."

known to exist, but nobody knows how to distribute it at the census tract level. So, for the purpose of calculation, bias was assigned a value of zero.

In census adjustment bias is arguably the most critical source of error[18]. It is difficult to give currency to any evaluation that makes bias disappear by means of computational fiat.

5. Do census blocks matter?

The Census Bureau's current position is that accuracy at the census-block[19] level is not an appropriate criterion of accuracy[20]. This position echoes a 1997 National Academy of Sciences report[21]. It appears to be a strategic sacrifice. There is no claim that census accuracy will be improved at the census block level with statistical adjustment. Indeed, there is good reason to believe the opposite. According to a 1995 National Academy of Sciences report, nonmatches between the 1990 census and the PES occurred in "relatively few number of [block] clusters."[22] In other words, most census blocks cannot gain from adjustment.

Arguing whether or not it is worthwhile to sacrifice block-level accuracy to achieve a larger good is not the purpose of my commentary. I would, however, simply point out that the downgrading of the importance of block-level accuracy is a recent development. In 1995 the position of the National Academy of Sciences was different:

> For congressional redistricting or for local-area decisions that involve relatively small areas, the relative accuracy of the population count for blocks and aggregations of blocks is important.

Appendix E of the 1995 NAS report is a catalog of activities for which local and state governments depend on block-level census data. I hope that the sacrifice was carefully weighed.

6. Useful demographic benchmarks

The Census Bureau discussed benchmarks from demographic analysis that were used in deliberations on the accuracy of the 1990 adjustment. One of the difficulties of evaluating an adjusted or unadjusted census is that there are few reality checks. Demographic analysis is an alternative source of information on population counts, but it

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[18] Breiman, Leo, "The 1991 Census Adjustment: Undercount or Bad Data?" Statistical Science (9) 458–475 gives a thorough account of the sources of bias that affected the PES. See also the CAPE report.
[19] A census block is the smallest unit of census geography, containing on average about 35 persons.
[20] Census Bureau, Federal Register, Vol. 65, No. 119, p. 38376.
[21] White, Andrew A. and Rust, Keith F., eds., *Preparing for the 2000 Census: Interim Report II*, National Academy Press, Washington, 1997, p. 12.
[22] Edmonston, Barry and Schultze, Charles, eds., *Modernizing the U.S. Census*, National Academy Press, Washington, 1995, p. 37.

is useful only at the national level. It would be desirable to have reality checks that addressed accuracy concerns below the national level. Fortunately, it is within the means of the Census Bureau to provide these checks, if it is willing to do so.

Useful quality measures can be obtained by comparing ratios of male to female children. In the 1990 census about 51% of children were males and 49% were females, a composition that was remarkably consistent across the nine U.S. census regions, across races, and across large metropolitan areas[23]. It is, moreover, unlikely that the dynamics of undercount are different for male and female children. The ability of an adjusted or unadjusted census to preserve the "51-49" sex ratio for children under the age of 18 across post-strata may provide useful insights into statistical reliability[24].

This observation suggests a reality check that can be reported with a statistically adjusted census—namely, separate statistical adjustment factors for males and females, in post-strata comprised of children in the 0–17 age group. Under the current post-stratification for the A.C.E. these separate correction factors are not provided, because the sexes are combined in the ages 0–17 post-strata, and only in these post-strata.

I therefore recommend that the Census Bureau report correction factors, with estimated standard errors, for males and females separately, in each of the 64 post-strata comprised of children in the 0–17 age group. This can be done notwithstanding the fact that the Census Bureau combines males and females in the actual adjustment. This information would be useful to statisticians and demographers in reaching their own, independent conclusions about the efficacy of statistical correction of the census.

7. Towards a meaningful dialog

In its preliminary determination the Census Bureau stated that "the criteria and the process that will be followed for the assessment of the A.C.E. results will be shared and discussed with outside statistical experts and other interested parties in the fall of 2000."[25] I welcome the Census Bureau's desire to facilitate dialog with statisticians and other experts outside of the Census Bureau. The form that this dialog will take, and its duration, will determine its value both to the Census Bureau and to the scientific community.

The Census Bureau has committed itself to achieving an "open and transparent planning and decision processes." For outside experts who already know how to navigate the Census Bureau, or enjoy access to those who are able to navigate it for them, this may

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[23] Darga, Kenneth, "Straining Out Gnats and Swallowing Camels: The Perils of Adjusting for Census Undercount," Michigan Department of Management and Budget, November 1997, p. 13.

[24] These ratios were obtainable from the original post-stratification of the 1990 PES. When the Census Bureau later reduced the number of post-strata from 1,392 to 357 it collapsed males and females in the youngest age groups, thereby eliminating the information needed to construct sex ratios. The post-stratification of the A.C.E. similarly collapses males and females in the 0–17 age groups. Sex ratios can be constructed for other age groups, but there are no reliable baselines to which they can be compared.

[25] Census Bureau, *Federal Register*, Vol. 65, No. 119, p. 38370.

be the case. For others the reality is somewhat different. Census Bureau reports and documentation on statistical adjustment are not catalogued to facilitate external access, and the means of acquiring information is not clear. This is perhaps best exemplified by the A.C.E. itself—documentation on survey design, data processing, and statistical methodology is not easy to find. I hope that the Census Bureau will promote transparency and meaningful dialog with outside experts by addressing this problem.

It is unfortunate that the time frame for dialog will allow for only a limited exchange of ideas with independent, outside experts before the Census Bureau must report census tabulations to the States. Nonetheless, a continuing dialog conducted in an atmosphere that promotes substantive and independent inquiry will be to the benefit of both the Census Bureau and the scientific communities that are interested in census issues.

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